

CHANGES IN THE CARDIO-VASCULAR SYSTEM OF MAN IN HEALTH AND DISEASE PRODUCED BY FILLING OF THE URINARY BLADDER

(ELECTROCARDIOGRAPHIC AND BLOOD PRESSURE STUDY)

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When the sensory end organs of the urinary bladder are stimulated definite reflex changes take place in the cardio-vascular system [2, 11, 13, 17, 19 and others]. Investigations carried out, in most cases under experimental conditions were centered primarily on studying the changes in cardiac rhythm and arterial tension that occurred with filling of the urinary bladder. Lately new papers have appeared dealing with the reflex actions of the sensory end organs of the urinary bladder on the cardio-vascular system of man. E. I. Likhtenshtein [9] observed patients with hypertrophy of the prostate whose attacks of angina pectoris were connected with a "sensation of an overfilled urinary bladder".

The author also noted a pronounced decrease in the T wave of the electrocardiogram with "maximum filling" of the bladder in healthy man. The investigations of O. M. Krynsky [7] carried out on healthy subjects showed significant changes in the electrodiagrams when a physiological solution was run into the urinary bladder until a sensation of fullness was elicited.

In the above-mentioned experiments it was shown that a pronounced pressor reflex may be obtained from the sensory end organs of the bladder. There are also clinical observations in part on patients with prostatic hypertrophy, showing a rise in arterial tension with overfilling of the bladder [21].

L. A. Efremova, M. Ya. Ratner, and V. M. Chayutin [6] came to the conclusion that increased arterial tension accompanying a gradual filling with fluid of the urinary bladder depends on direct reflex action arising from its sensory end organs. Few investigations in man on the reflex action of the urinary bladder on the cardio-vascular system are carried over in principle to the healthy human.

In this study an attempt was made to follow through the changes taking place in the sick cardio-vascular system and in the bladder during filling.

A total of 50 experiments were carried out on 47 patients (46 women and 1 man): Group I had 23 patients afflicted with hypertension and atherosclerosis ; Group II — 11 patients with pyelocystitis, and Group III — 13 practically healthy adults.

EXPERIMENTAL METHODS

We studied the reflex action of the urinary bladder on the cardio-vascular system by filling the bladder within physiological limits and excluding cortical action on the latter (sensation of overfilled bladder and strong urge to urinate).

A weak rose solution of potassium permanganate from a calibrated vessel was introduced into the bladder of the subject via a thin rubber catheter.

After determining a definite level of arterial tension a control electrocardiogram was inscribed. Then fluid was run into the bladder gradually. Following the administration of every 50 cc of fluid a new ECG was taken and arterial tension measured.

To exclude cortical effects the administration of fluid was stopped immediately upon the appearance of the first urge to urinate; an ECG tracing was recorded and the tension determined (this was repeated ten minutes after the urge, immediately and 10 minutes after releasing of the fluid).

EXPERIMENTAL RESULTS

In a series of experiments in the group of practically healthy women, aged 25-60, without any illness of the cardio-vascular or urinary systems, several changes could be observed in the cardio-vascular system on gradual filling of the urinary bladder with a slowing of the heart rhythm (6-10/min., see table). A slight tendency to shortening of the electrical systole and a decrease of the systolic index (7-26%) were noted. In two women there was an insignificant increase in auriculo-ventricular conduction (0.02-0.03 sec.), and in two experiments T_1 and T_2 showed a 1 mm increase.

Of seven women in this group on whom arterial blood pressure studies were carried out, two showed a maximal increase and one a minimal decrease of 10 mm.

All noted changes appeared prior to the first urge to urinate (after running in 200-400 cc of fluid) and disappeared rapidly, often at the very moment of its appearance.

Group II, of patients afflicted with hypertension and atherosclerosis, consisted of 23 women, aged 36-68. In 21 of these hypertension was diagnosed (15 neurogenic, 6 transitional): in 9 in connection with marked atherosclerosis of the vessels; in 5 atherosclerotic signs were less pronounced, and such signs were absent in 3 patients. Two patients had atherosclerosis of the cardiac vessels and normal tension and 14 had angina pectoris.

Electrocardiograms pointed to diffuse changes in the myocardium in 4 patients, coronary insufficiency in 3 patients, and old focal changes in the myocardium of 4 patients, together with left axis deviation or more or less hypertrophy of the left ventricle.

Cholesterin content of the blood of this group varied between 180-310 mg %, often over 225 mg % (in healthy women 160-224 mg %). At the time of investigation there were no signs of pronounced cardiac insufficiency or of dysfunction of the urinary organs in any of the patients. In this group the urge to urinate appeared after running in 150-350 ml of fluid. Changes in the ECG were noted up to the appearance of the urge. The cardiac rhythm diminished by 5-15 beats per minute in the majority of patients [11] and was rarely increased (see table).

In some patients a decrease in heart rhythm alternated with an increase at the time of appearance of the urge. When the fluid was released, the rate diminished. In four patients with a somewhat increased auriculo-ventricular conduction time (0.20-0.21 sec.) the height of the PQ wave became normal under the influence of filling of the bladder.

In one patient with a prolonged intraventricular conduction time an atypical block of the right branch of the bundle of His disappeared under the influence of filling of the bladder (Fig. 1).

In a number of patients the P wave often diminished but sometimes became larger, up to 1.5 mm. In 1/3 of the instances there was a diminution of T₁-T₂; in 3 patients the T wave was increased 1-3 mm, and in 3 patients there was some depression of the ST segment (I-II).

TABLE

Change in Cardiac Rate During Bladder Filling.

Change in the number of heart beats per minute	Filling of the urinary bladder (up to urge)			Urge			Release of fluid		
	Healthy subjects	Hypertensives	Cystitis patients	Healthy subjects	Hypertensives	Cystitis patients	Healthy subjects	Hypertensives	Cystitis patients
3-5	-	+ + - -	+ +	+ -	+ + +	+		- - -	-
6-10	+ + -	+ + + - -	+ +	+ - -	+ + + +	+ -	-	+ + - -	- -
11-15	-	-	+ + +		+ +	+		- -	
16-20	-		+		+				
un-changed	00000	00000 00	0	000000 0	000000 0000	000000	000000 000000	000000 00000	000000 00

Legend: + accelerations, - decrease in frequency, 0 unchanged.

In 13 hypertensive patients the arterial tension showed a significant increase on filling the bladder. (10-40 mm, more commonly 20-30 mm, and a minimum of 10 mm); the increase in tension occurred up to the appearance of the urge, where it remained, and came down to the lower limit 10 minutes after cessation of filling the bladder, and often increased at the time of release of fluid.

The cardiac rhythm showed almost no change with pronounced atherosclerosis, but the T wave was diminished more often than in other patients. Shortened a-v conduction time, depression of the ST segment, and an increased T wave were noted in patients with less pronounced coronary atherosclerosis. In 7 hypertensives in the transitional stage more significant changes in the arterial pressure were noted.

Ten men and one woman, aged 25-60, were in the group of pyelocystitis patients. In 7 of them cystitis or pyelocystitis was diagnosed and in 4 the cystitis was accompanied by other urological conditions (Tuberculosis of the kidneys, nephrolithiasis, cancer of the bladder). All of these patients were examined in the acute stage of pyelocystitis; none of them showed any significant abnormalities of the cardio-vascular system.

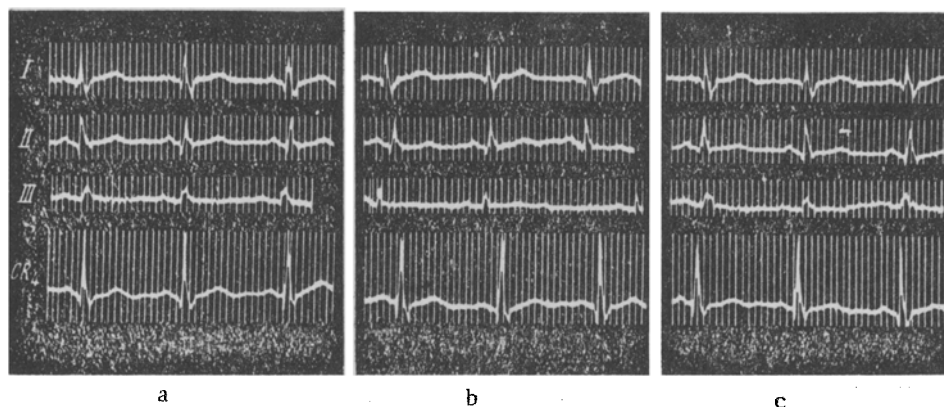


Figure 1. Patient A, ECG. Coronary atherosclerosis; cardiac atherosclerosis.

- a) Before filling of bladder (atypical block of the right branch of the bundle of His);
 b) at time of filling (200 ml) up to the urge (disappearance of the atypical block of the right branch of the bundle of His);
 c) ten minutes after appearance of the urge (reappearance of the atypical block of the right branch of the bundle of His). Leads are shown on the left.

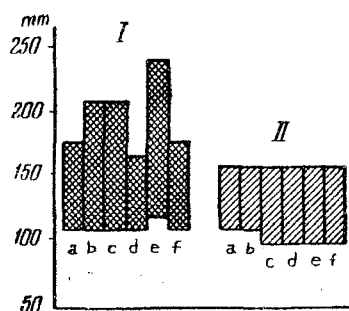


Figure 2. Patient C. Changes in the arterial tension during filling of the bladder. Diagnosis: Hypertension, transitional stage.

- a) Before filling; b) filling, up to the appearance of the urge; c) at the time of the appearance of the urge; d) 10 minutes after; e) immediately after emptying; f) 10 minutes after emptying. I — Before novocainization; II — after novocainization.

In pyelocystitis patients the urge appeared on running into the bladder 150-250 ml of fluid. The following ECG changes were noted up to the appearance of the urge to urinate; in 8 of the 15 patients the cardiac rate increased 10-15 beats per minute (at the time the urge appeared the rate remained accelerated in only two patients).

A tendency to prolongation of electrical systole was noted (in 5 patients on filling the bladder the QT wave was below normal limits for the given rate)* and in 9 patients the systolic index was prolonged 13-20 %. In 7 patients the a-v conduction time was increased by 0.03-0.06 sec. (Fig. 3). The P wave was increased by 0.75-1 mm, in 6 patients, and in 3 others a slight decrease was noted.

Under the influence of filling of the bladder a pressor reaction of short duration was noted in 6 patients (at the time the urge to urinate was felt it disappeared in half the cases). The pressor reaction was usually 10 mm (for maximum and minimum pressures); in one patient the maximum pressure was increased by 25 mm. Release of the fluid from the bladder was not accompanied by a change in pressure.

It should be emphasized that at the time of the investigation no unpleasant sensations were noted either from the cardio-vascular or urinary systems. On filling the urinary bladder there was only a slight urge.

* According to table of Hegglin and Holzmann.

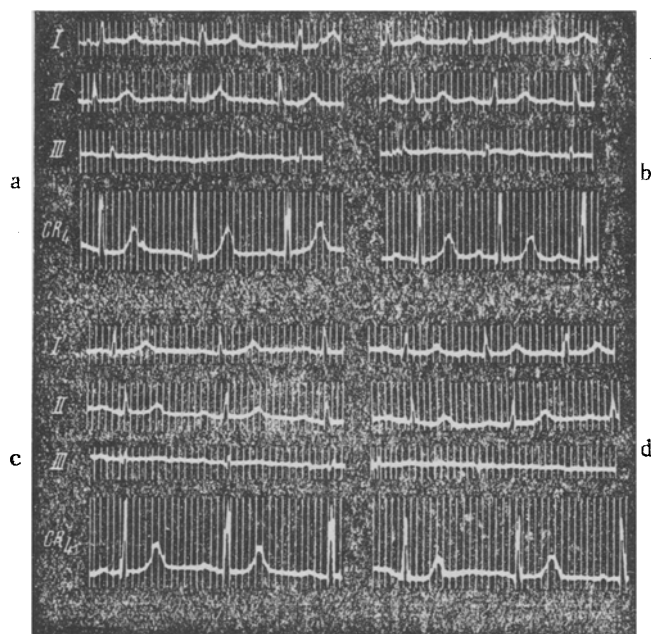


Figure 3. Patient M. ECG change during filling of the bladder. Diagnosis: Pyelocystitis. a) Before filling the bladder (PQ 0.15 sec); b) during filling until the appearance of the urge (PQ 0.2 sec; increased P_2 , PCR_4); c) at appearance of the urge (PQ 0.2 sec; P as in b); d) ten minutes after emptying (PQ 0.17 sec; P_2 , PCR_4 again diminished).

To prove the reflex nature of the observed phenomena the mucous membrane of the bladder was anesthetized with novocaine in three subjects. After novocainization, filling the bladder with the same amount of fluid that previously produced distinct changes in the cardio-vascular system, did not cause any ECG changes (Fig. 2).

EVALUATION OF RESULTS

Our data showing slight changes in the ECG on filling the urinary bladder are at variance with those of Krynsky and Likhtenshtein [7, 9]. Reflexes arising from the sensory end organs of the bladder and affecting the cardio-vascular system are of the allied type [16]. V. M. Chayutin [15] points out that allied reflexes, particularly from the urinary bladder on arterial pressure, are weaker than organ reflexes proper. It seems to us that the pronounced changes in the electrocardiogram noted by Likhtenshtein and Krynsky could depend in significant degree on the cortical reaction to a strongly felt urge to urinate that was called forth by a "maximally filled" urinary bladder; according to Krynsky essentially the same changes appeared in the ECG with maximally intended retention of urine.

Of vital interest are the peculiarities and strongly pronounced reflex changes that occurred in the cardio-vascular system on filling the bladder of patients afflicted with hypertension and atherosclerosis or cystitis by comparison with those observed in healthy subjects.

In patients with cystitis the reflex changes (increased frequency of heart beat instead of slowing, prolongation of the heart's electrical systole, prolongation of a-v conduction, greater frequency of P wave changes than in healthy subjects) are apparently connected with the functional condition of the receptors and tissues of the injured urinary bladder and changes in the character of afferent impulse formation.

Deformity of sensory end organs on stretching smooth muscle is a stimulating factor in a hollow organ, while the extent of deformity depends on the functional condition of the tissue at time of stimulation [14]. N. A. Adamovich noted a change in afferent impulses in the pelvic and hypogastric nerves in patients with cystitis.

In hypertensives and atherosclerotics the peculiarities in the changes that occur in the cardio-vascular system apparently depend on the damage in hypertension to the functional state of central organs that regulate the c-v system (increase in frequency of the heart rate even when the urge was weak, significant degree and prolongation of increase in arterial tension) and on the atherosclerotic affection of the cardio-vascular system, primarily on the condition of the cardiac musculature.

Changes in the reflex action of the cardio-vascular system in atherosclerosis were noted experimentally and clinically. It is necessary to note the very marked changes in arterial tension in patients in the transitional stage of hypertension (as compared with those in the neurogenic stage). It is usually considered that the pressor (cold) and depressor reactions are more common in patients in the neurogenic stage of illness [8]. Still in our previous investigations [3] on stimulating the receptors of the vestibular apparatus we noted a more pronounced pressor reaction in the transitional stage. Possibly, the reaction of the cardio-vascular system depends to some extent also on the receptor field from which the stimulus originates.

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